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ABSTRACT

Despite gains in many areas, minorities remain underrepresented as scientists and science students. On of the reasons for this absence may be the presence of a common stereotype of scientists as white males. This paper argues that recent research in cognitive and social psychology shows that stereotypic processes are not automatic and that stereotypes can be reversed through the use of multimedia software in the science curriculum that includes graphic images with specific occupation and background information about ethnic groups. Community college students who used the counterstereotypic version showed less negative stereotypic attitudes afterwards compared with students using the same software without the counterstereotypic images, when used within a course context that included discussion of cultural differences. Based on quantitative stereotypic attitude changes, a two-step model for implementing changes in classroom curriculum is proposed that could influence student stereotypes about who becomes a scientist and perhaps lead to an increase in the number of minorities studying and practicing science. (Contains 45 references.) (Author/MES)

Using Multimedia to Counter Stereotypes in Science Classrooms: New Perceptions of Who Becomes a Scientist

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USING MULTIMEDIA TO COUNTER STEREOTYPES IN SCIENCE CLASSROOMS: NEW PERCEPTIONS OF WHO BECOMES A SCIENTIST

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Abstract

Despite gains in many areas, minorities remain underrepresented as scientists and science students. One of the reasons for this absence may be the presence of a common stereotype of scientists as white males. I argue in this paper that recent research in cognitive and social psychology shows that stereotypic processes are not automatic, and that stereotypes can be reversed through the use of multimedia software in the science curriculum which includes graphic images with specific occupation and background information about ethnic groups. Community college students who used the counterstereotypic version showed less negative stereotypic attitudes afterwards, compared with students using the same software without the counterstereotypic images, when used within a course context which included discussion of cultural differences. Based on the quantitative stereotypic attitude changes seen here I propose a two-step model for implementing changes in classroom curriculum which could influence student stereotypes about who becomes a scientist and perhaps lead to an increase in the number of minorities studying and practicing science.

Introduction

Despite 2 decades of federal programs and funding to increase the representation of women and minorities in science, there have been few changes in the percentages of underrepresented groups in science….and efforts to raise the numbers of minority scientists show no appreciable gains.... Eisenhart, Finkel and Marion, 1996.

"Mami, cuando crezca quiero ser biologo de moleculas, even though we don't know anyone who does that job." The number of African-Americans, Latino/Hispanics, and Native Americans studying and practicing science makes it difficult for children in some communities to envision themselves in certain careers. For example, in 1988 only 3% of scientists were Latino/Hispanic although that ethnic group comprised 7% of the labor force (National Science Foundation, NSF, 1990) while African-Americans were even more underrepresented as 3% of the scientists and 10% of the work force. Five years later, the percentage of African-American and Latino/Hispanic scientists remained the same, although both groups increased in the general population[1] (NSF, 1996).

All levels of school seem to play an important role in the formation of who decides to become a scientist. A recent analysis of 8th and 10th grade students' performance in science using a national, longitudinal database (NELS:88) found that schools themselves may be a major cause for the absence of women from science (Burkham, Lee and Smerdon, 1997).

> "...it is discouraging for us to report that girls are still learning less science than boys. It is even more discouraging to find that the gender gap favoring boys appears to increase as students move through the educational system. This suggests that schools have an active role in gender stratification, rather than simply reflecting societal influences related to gender" (p. 321).

Schools have also been shown to play an active role in the underrepresentation of ethnic groups in science (Harding, 1993; Solorzano, 1994).

A second main factor which contributes to the underrepresentation of minorities is the image held by students about who becomes a scientist and about ethnic groups. Nelkin (1987) highlighted how the mass media portrays scientists as overwhelmingly white. In the past three decades researchers have linked the white male stereotype to school children (Krause, 1977; Chambers, 1983). Recent data from a study of elementary student drawings of "a scientist doing science" confirms the continued existence of certain student stereotypes about who becomes a scientist (Barman, 1997). The most obvious feature of the 1,504 drawings was the prevalence of white males as depicted in 69% of the K-2 drawings, 80% of 3rd-5th grade drawings and 74% of the 6th-8th grade drawings. Scientists in the 1997 drawings, however, looked like "everyday" people instead of like the fictional "alien" creatures which were common to earlier studies. Barman correlated this change with curriculum reform in science that emphasized "activity-oriented science."

Others argue that holding certain stereotypes influences social judgments about future behavior (Jussim, Fleming, Coleman and Kohberger, 1996). For example, Banaji, Hardin, and Rothman, (1993) illustrated how implicit stereotyping ("effects attributed to unreportable residues of prior experience") occurred by incidental exposure to stereotypic information and they argue that this type of stereotyping unconsciously influences judgment. One consequence of implicit stereotyping is its effect on minority students. Some research has shown that stereotypes influence academic performance, including a report that African Americans receive lower grades than whites at all levels due to a negative stereotype that they are not as intelligent or able to succeed as whites (Wolfe and Spencer, 1996). This is not a recent occurrence. Three studies in the 1980's (Lockheed, 1985) looked at science performance for 9-year-olds and 13-year-olds and each found whites outperformed African-Americans by at least 15 percent.

Despite Barman's findings that elementary and middle school curriculum changes can affect the kinds of stereotypes that students use to predict who will become scientists, and despite the research that stereotypes contribute to minority underrepresentation in science, few researchers have looked at specific curriculum changes which could effectively counter existing stereotypes about scientists and minorities so as to provide encouragement for more minorities to study and succeed in science.

In this paper, I suggest that multimedia software which includes counterstereotypic clip art can be used to change students' images of who becomes a scientist. The first section reviews recent results in cognitive and social psychology which contradicted the prevailing view of stereotypes as an automatic, individuated response and which reveal ways that stereotypes can be reversed. I then illustrate how other psychology experiments have found content about occupation and socio-economic background to be effective in countering racial stereotypes. Next I describe how those findings informed the design of a multimedia software program about genetics as an attempt to counter existing stereotypes about African-Americans. Based on data from the use of such a program in a community college introductory biology class for non-majors I show how the addition of that software to the science curriculum contributed to changes in both students' stereotypic attitudes and their biology knowledge, within certain pedagogical contexts. Finally, I explore how instructional and curriculum designers can build upon these results and suggest a two-step non-linear model for implementation of curriculum changes.

Automatic and controlled processes in stereotyping

For many years, psychologists have assumed (and persuaded the rest of us) that stereotyping is an "automatic" brain activity. This implied that both encoding (Banaji, Hardin and Rothman, 1993) and retrieval were unintentional, involuntary, effortless, autonomous and occurring outside of awareness (Bargh, 1989). To investigate these processes psychologists rely on providing different lengths of time for the brain to respond. Giving an experimental participant less than 350 ms to respond assumes an "automatic" cognitive activity while longer times are assumed to indicate more "intentional" processes and more control.

The original distinction between automatic and intentional was refined to include <u>activation</u> of a stereotype (by situational cues such as skin color) and <u>application</u> (where the perceiver uses the activated stereotypic information in a judgment). Until 1996, these two were seen as sequential and activation was considered to be an automatic process while application was viewed as a controlled (or controllable) process. This implied that many responses which disadvantaged one ethnic group over another were automatic and beyond the individual's control.

In 1996, Irene Blair and Mahzarin Banaji published their findings about ways that perceivers might moderate the automatic processes. First, they found evidence that confirmed the automaticity of some responses and then they investigated the nature of automaticity itself. They used a complicated psychology research technique called "semantic priming" which is based on the belief that people respond faster to a target word if it is paired with a second word that is semantically associated with the first word. For example, people would respond faster to "nurse" if it is paired with "doctor" than if it is paired with "tree." Psychology researchers use this concept and measure the time it takes people to react to the second word (target word) of paired concepts. When two words are stereotypically associated, such as "dependent" with "Jane", a faster reaction time indicates a stronger stereotype by indicating a stronger association between the two words.[3]

After establishing automatic responses to stereotypes using semantic priming Blair and Banaji changed the instructions given to participants so as to moderate the priming. Some subjects were given a stereotypic strategy by being told to expect an associated second word, i.e. "Jane" would follow "petite". Others were instructed with a counterstereotypic strategy by being told the opposite, i.e. to expect that "Jack" would follow "petite." They did the experiments at both 350 ms and 2000 ms intervals. The most startling result was that the counterstereotypic instructions reversed the priming within the 2000 ms interval but not within 350 ms.

If the brain acted so quickly that an automatic response was presumed, it followed instructions when they matched the priming; it gave faster response times to stereotypic pairs when it was given stereotype instructions and it gave faster responses to counterstereotypic pairs when given counterstereotypic instructions. However, when allowed a longer time to respond (2000 ms), so as to include intentional processes and more control, the brain also followed counterstereotypic instructions with stereotypic pairs and gave slower response times with those pairs and faster response times with counterstereotypic pairs--in direct contradiction of the automatic aspects of the stereotyping process. In other words, when the cognitive processes were more controlled, participants were able to modify the automaticity of the stereotyping process.

If one accepts the results of Blair and her colleagues that environmental information can contribute to encoded stereotypes but that this information is controllable and changeable, the question then becomes what kind of information could be used to counter existing negative stereotypes. Social psychology research within two wellaccepted theories (complexity-extremity theory and assumed characteristics or trait attribution theory) sheds additional insight to begin to answer that question. [4]

Theories on the influence of stereotypes

Complexity-extremity theory suggests that people have more information about their own group than about other groups and that the more information they have, the less extreme their evaluation will be. Patricia Linville and Edward Jones (1980) did a series of experiments which looked at how members of one cultural group (the "in-group") evaluated members of another cultural group (the "out-group"). In one experiment, male subjects were given a packet of 40 cards which each contained a personality trait which had been pre-tested to reflect traits of both black and white undergraduates. They were told to sort the 40 traits into groups. Some subjects were told to think about White male undergraduates while sorting and other participants were told to think about black male undergraduates while sorting. Their all-white participants formed significantly more groups when thinking about whites than about blacks and scored higher on a conceptual complexity index test.[5]

These results suggested that whites had greater schematic complexity regarding in-group members than out-group members. The extremity of an evaluation is theorized to depend upon the richness (greater schematic complexity) of one's conception of the "other's" social group, that is, richer information results in a less stereotypic attitude. Variations in schematic complexity are also important because they suggest differential influences for new information since a simple and impoverished schematic about out-group members is likely to be heavily impacted by a small amount of new information.

Trait-attribution theory (also called assumed-characteristics theory) proposes that a person with information about only a few traits will use broad complexes which include many traits to evaluate another person. For example, information about skin color leads people with limited information about the other individual to make assumptions about socio-economic status, personality traits, or values.

One line of trait-attribution studies looked at racial stereotypes in light of information about background and occupation. Jack Feldman (1972) had college students generate descriptive adjectives for four categories: "Negro", "white", "professional" and "working class". Other college students then selected a percentage for each adjective which represented the number of people from each of the four categories that would, in their opinion, exhibit that trait. A comparison of white and black categories showed that the occupational stereotype was much stronger and more differentiated than racial stereotypes. Professional background and working-class occupation were rated significantly higher on the black stereotype than were other adjectives. In other words, "professional blacks" were more professional than comparable "professional whites."

Feldman argued that professionals are accorded more traits and rated higher on those traits than are working class people. He concluded that the black stereotype is "in reality, a *lower-class* black stereotype, and that when contradictory information is presented, it takes precedence over race" (1972, p. 338).

If complexity-extremity theory underscores how small amounts of new information about out-group members can be influential and if trait-attribution theory offers information about occupation and background as effective influences, the question becomes, what kind of information about occupation and background should be provided? Alice Eagly & Valerie Steffen (1984) have shown that the new information can be extremely general. In their experiment, they read a short sentence to participants about a person (e.g., "Phil Moore is about 35 years old and has been employed for a number of years by a supermarket. He is one of the managers"). All descriptions included being employed by either a bank, a supermarket, a medical clinic or a university department of biology. Occupational status was conveyed by job title. "Vice-president," "manager," "physician" and "professor" were used to indicate high-status while "teller", "cashier," "x-ray technician" and "lab technician" indicated low-status. Participants then rated each person on personal attributes indicating communal (selflessness and concern with others) and agentic (self-assertion and urge to master) qualities which were selected to reflect gender stereotypes. The results indicated that the extremely general information about employment status caused participants to revise their estimates of women's and men's communal and agentic qualities away from existing gender stereotypes.

These studies suggest that prejudiced responses and behavior based on negative stereotypes need not be viewed as inevitable, that incidental exposure to stereotypic knowledge can unconsciously and selectively influence judgment but that exposure to counterstereotypic information can moderate the effect of the stereotype. They also imply that providing information about a member of another group can lessen the effect of already-held stereotypic knowledge, especially if the new information contains a counterstereotypic occupation or background.

Can a similar inference be made about the effectiveness of including certain specific attributes in a curriculum as a way to counter the effects of implicit stereotypic knowledge? The psychology studies all involved experimental laboratory conditions where the information was specifically presented to the brain in ways that ensured that certain cognitive processes would occur and where it was highly likely that each participant would absorb the counterstereotypic information. For educators to benefit from this work they have to find ways to incorporate counterstereotypic information into the curriculum under conditions that encourage a similar absorption.

To begin to answer that question, the next section looks at two studies where teachers successfully integrated counterstereotypic information into the classroom curriculum.

Lessons from the classroom

Lorie Strech (1994) looked at existing racial stereotypes with third-graders in California before and after they completed a social studies unit which focused on the school's diverse community. One section of the curriculum included activities to compare their community from the past to the present. A second part of the unit included literature which focused on the concept of communities and a third component was aimed at dispelling stereotypes by having students observe the kinds of occupations present in their neighborhood and the kinds of people holding those jobs. Students reported their data to the class as part of a discussion on stereotypes involving jobs. An African-American female psychologist also visited the class as a role model.

Students were given a pre- and post-test which measured their association between certain ethnic groups (described through photos of African-Americans, Hispanic-Americans, Asian-Americans and European-Americans). The curriculum unit was found to moderate stereotypes with 13% more post-unit responses falling in "neutral" categories than in negative or positive ones. For example, the number describing "janitor" as the occupation for African-Americans fell from 60% in the pre-unit test to 27% on the post-unit test (to be replaced by "football player" at 60%). A similar shift appeared for stereotypes of Asian-Americans. While 77% of the pre-unit responses were "gardener", that changed to 17% after the unit, and "teacher" became the most prevalent with 57%. 6

In another study Richard Johnson and Joseph Tobin (1992) used a videodisk module in a University of Hawaii education class to help pre-service teachers understand stereotypes underlying classroom discipline. The software included interviews with a Samoan social worker, a Chinese high school student and a Japanese-American professor which illustrated a variety of perspectives about how different cultural groups are stereotypically treated in the classroom. The authors' conclusions, based on qualitative analysis of student responses and critiques, suggest that the education students changed some of their stereotypes after viewing the program. The change in stereotyping information came about when pre-service teachers were provided rich information about three varied ethnic groups.

While these two projects support the effectiveness of a small curriculum modification for influencing the use of stereotypic information, they concerned social studies and education courses where the content could naturally include a focus on culture. In science, the adoption of strategies designed to narrow the gender gap in science (i.e., increasing student confidence, student performance and student interest in science, as suggested by Burkham, Lee and Smerdon, 1997) has failed to change the fundamental perception by students about who becomes a scientist, as seen in the 1997 study of elementary school drawings. While the importance of these programs should not be discounted, it appears that we also need to find another way to introduce counterstereotypic information into science (and other) classrooms.

One of the obvious possibilities is to use pictures since they have previously been shown to enhance learning in certain contexts and they can quickly convey large amounts of detailed information.[7] Here, in contrast to the issue usually facing instructional designers of <u>which</u> picture to use, we know the information that should be included, and can rely upon the established principle <u>that</u> pictures, when used appropriately, effectively enhance learning. The Johnson and Tobin videodisk relied heavily on images through the use of video for capturing interviews with three people so their comments could be available for student reflection outside classtime. Although the presence of role models and the in-class appearance of experts might be preferable, the Johnson and Tobin study shows certain advantages of technological presentation of images and counterstereotypic information for science classrooms. Digital resources are not dependent upon a teacher's personal knowledge, cultural experiences or contacts in diverse communities. Science is also especially receptive since it is one of the subjects where success requires familiarity and mastery of technology (Songer, 1989).

The technology used by Johnson on the videodisk included a wide variety of elements which would generally qualify as "multimedia", a term for software programs that combine text, graphics, animation, audio, video and interactivity (Lopuck, 1996). Classroom multimedia can provide students with opportunities for independent learning, problem-solving, communication and self-assessment (Platt, Obenshain, and Friedman, 1994). The use of a multimedia program which included counterstereotypic images would allow a student to absorb counterstereotypic information at her or his own pace and comfort level.

Successful use of multimedia in the curriculum has been shown for anchored instruction (Bransford, et. al., 1990), as part of cognitive flexibility (Spiro, et. al., 1992) and within a cultural constructive perspective (Peters and O'Brien, 1996). The multisensory elements have been shown to address a diversity of learning styles (Dunn, 1990) and to attract students' attention and keep them engaged. Static computer graphics have been shown to facilitate learning (Alesandrini, 1987) and research on the movement of graphics (animation) has also shown direct connections to enhancing learning (Enyedy, 1997; Windschitl and Andres, 1998).

Perhaps more importantly for the purpose of conveying information, multimedia typically includes a lot of graphics. Graphics are used to illustrate ideas in multimedia, as part of animations, as interactivity button icons and to communicate navigation (e.g., left-pointing arrow means "go back"). This expectation provides a myriad of unobtrusive opportunities for including counterstereotypic images. In short, multimedia appears to provide a potential curriculum resource which can easily include counterstereotypic images which convey occupation and background information. Could the use of such software change attitudes of students toward members of an out-group?

Methodology

Software

To investigate this question three versions were created of a multimedia software program. All versions were designed to be used as a review for a unit test which included Mendelian inheritance genetics by helping students check their own comprehension in a game format. Each had the same content, divided into five sections and accessed from a main menu. The content was designed to be easier at the beginning, with the first section containing vocabulary words. The next four sections were alphabetically labeled with questions on monohybrid crosses, dihybrid crosses, x-linked genes and multiple alleles. There were five questions for each section plus a bonus. All versions included a total of 30 questions.

The software was made with a multimedia authoring program (ToolBook by Asymetrix, Inc.) which uses the metaphor of a book. The information on each screen appears as a "page" which remains until the user navigates (usually by clicking a button) to the next "page" or screen. The software is also object-oriented, so information is presented using static objects such as text fields, created within the program, or by importing graphic, audio or video files. All objects can be sized or moved to create animation. The software is also event-driven, so that user actions such as moving the mouse on top of a screen object, clicking an object or entering a "page" causes other actions to occur, such as a text field appearing (i.e., to provide feedback) or a circle moving (i.e., to look like a bouncing ball).

The versions differed in the basic way they presented the information. The first version (hereafter called the Web-page based version) included only multiple choice questions created by the textbook publisher. The first 18 questions were copied, word-for-word, from the publisher's Web page. Once a student selected an answer, one of two text fields appeared: "Your answer to question #1 was correct" or "Your answer to question #1 was incorrect. Please refer to page 239 in [name of textbook author]." The last 12 questions were taken, also word-for-word, from the back of the textbook chapter and showed the question along with a button which accessed the answer.

The second version of the software was a "game" (hereafter called plain multimedia version) where students scored points by answering questions. A wrong answer triggered an audio file of a dog howling along with the appearance of a text field as immediate feedback which included the correct answer and a short explanation. A correct answer brought applause and access to a "game" which included either archery, bowling, pool, basketball or darts, depending on the content section. Points accumulated and a running total was shown on subsequent pages.

The third version (hereafter called the counterstereotypic version) included ethnocentric clip art and had two differences from the plain multimedia version. It included five images taken from a commercial "Afrocentric" clip art collection where the characters were all African-Americans. Images were selected which showed high-status occupation and background information or could be modified to include such information. Afrocentric clip art was chosen to correspond with the stereotype measure questions which asked participants about "Blacks." For example, identification as a doctor or holding a Ph.D. was designed to convey a high status occupation or background.[8] Each image was positioned around the question, usually on the left, so as to be seen when the student read the question. A second difference was that a popular Mexican game similar to Anglo-Saxon Tarot cards was used instead of archery in one section and Wari, a common African game was substituted for bowling in another section.

Classroom Setting

The study was conducted with two sections of a 4-credit course for non-majors at an urban community college in a major city of the Southwest. Students take this course to fulfill their general science requirement for an Associate of Arts or Associate of General Studies degree. Most had graduated from high school but some earned G.E.D.s; the youngest was 19 years old and the oldest was in her 40's. The campus is notable for the diversity of student ethnic backgrounds and in this study, there were 14 whites (self-identified), 13 Hispanics, 2 Native Americans, 7 African-Americans, 2 Africans, one Thai and 4 Asians. One class met in the evenings and included older, "second-career" students while the other section was an afternoon class with more younger students.

Forty students in two class sections, including one that I taught, used the software individually in a computer lab as part of a regular class laboratory exercise. While each section dealt with genetics at different times in the semester, both spent the same number of class periods and both used the software as a review during the week before a unit test. Prior to entering the computer lab, students were orally informed of their rights concerning consent and participation and completed two surveys, one on computer attitudes (Kay, 1989) and a second one on stereotypes. The stereotype scale had been created with 10 pro-Black and 10 anti-Black statements and previously validated with 174 white students at Brooklyn College and Lehman College (New York City) using principal-components factor analysis with varimax rotation (Katz and Hass, 1988). An example of a pro-Black statement is "Black people do not have the same employment opportunities that Whites do" and an example of an anti-Black item would be "On the whole, Black people don't stress education and training." Four items (two of each type) were keyed in reverse.[9]

After completing the questionnaires, the students moved to a computer lab, started the program, entered a code number,[10] selected their gender and answered the question "Briefly describe your cultural background by typing in the gray box". The next five screens displayed five genetics problems, with multiple choice answers, which functioned as the biology knowledge pre-test. Leaving the last question triggered a random assignment to one of the three versions, based on the time in seconds. Upon completion of the review portion, each student took a post-test with five different genetics problems, exited the software and again completed the attitude toward computers and stereotypic attitude questionnaires (in the computer lab). The software also created a "log" for each student which recorded the time and content of events such as entering a page or typing an answer.[11]

Results

The pre- and post-software attitude measures were converted from Likert scale to numeric values such that higher scores indicated more positive attitudes toward a member of an out-group or toward computers. Initially, a 3x2x4X2 factorial design was used to analyze the data using SPSS 8.0 for Windows with a four-factor analysis of variance (ANOVA) with multiple variables including all three dependent variables (stereotypic attitude, computer attitude and biology knowledge) and with software version (3 levels), gender (2 levels), ethnicity (4 levels: white, Hispanic, black, Asian), and class section (2 levels) as independent variables. However, since there were no significant results for ethnicity as a factor (or for interactions involving ethnicity) a second ANOVA was used with the same three dependent variables but with only software version (TX) and gender as fixed factors. The two-factor ANOVA is shown in Table 1. It provides a more accurate description of this study because the sample size is small compared with the number of cells and the two-factor ANOVA eliminated the zero frequency cells without losing any significant information.

Table 1: Analysis if Variance with Only Software and Gender as Independent Variables

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	CAMDIFF	.636[a]	7	9.084E-02	.215	.97
	STERDIFF	3.012[b]	7	.430	3.273	.01
	QDIFF	25.985[c]	7	3.712	2.727	.03
Intercept	CAMDIFF	1.103E-03	1	1.103E-03	.003	.96
	STERDIFF	.789	1	.789	5.998	.02
	QDIFF	1.293	1	1.293	.950	.34
TX	CAMDIFF	7.345E-02	2	3.673E-02	.087	.91
	STERDIFF	1.013	2	.507	3.854	.03
	QDIFF	2.588	2	1.294	.950	.40
GENDER	CAMDIFF	4.954E-03	1	4.954E-03	.012	.91
	STERDIFF	1.880	1	1.880	14.300	.00
	QDIFF	1.024	1	1.024	.752	.39
CLASS	CAMDIFF	1.132E-02	1	1.132E-02	.027	.87
	STERDIFF	.311	1	.311	2.363	.14
	QDIFF	2.263	1	2.263	1.662	.21
TX* GENDER	CAMDIFF	.266	1	.266	.629	.43
	STERDIFF	.427	1	.427	3.250	.08
	QDIFF	1.347	1	1.347	.990	.33
TX* CLASS	CAMDIFF	8.058E-03	1	8.058E-03	.019	.89
	STERDIFF	2.214E-02	1	2.214E-02	.168	.68
	QDIFF	13.333	1	13.333	9.794	.00
GENDER* CLASS	CAMDIFF	4.011E-04	1	4.011E-04	.001	.97
	STERDIFF	1.089E-02	1	1.089E-02	.083	.77
	QDIFF	2.727	1	2.727	2.003	.17
TX*GENDER*CLASS	CAMDIFF	.000	0			
	STERDIFF	..000	0			
	QDIFF	.000	0			
Error	CAMDIFF	8.036	19	.423		
	STERDIFF	2.498	19	.131		
	QDIFF	25.867	19	1.361		
Total	CAMDIFF	8.674	27			
	STERDIFF	5.511	27			
	QDIFF	52.000	27			
Corrected Total	CAMDIFF	8.672	26			
	STERDIFF	5.510	26			
	QDIFF	51.852	26			

a. R Squared = .073 (Adjusted R Squared = .268)

b. R Squared = .547 (Adjusted R Squared = .380)

The two-factor ANOVA showed significant main effects for both software version and gender at the 95% confidence level for scores on the stereotyping attitudes scale (F=3.854, p=.039 and F=14.3, p=.001, respectively) but not for either attitudes toward computers (CAMDIFF, F=.087, p=.917) or for biology question scores (QDIFF, F=.950, p=.404). However, there was also a statistically significant interaction between class section and software version (F= 9.794, p=.006) on the biology scores.

The significant software version differences correlated use of the counterstereotypic version with positive changes in stereotypes. Overall mean scores for those who used the Web-page based software version dropped -.3833 between the pre- and post- results while those using the plain multimedia had mean scores that stayed about the same (a raw score change of +.003). Those using the software with counterstereotypic clip art saw a positive change in their stereotype attitudes of +.1656 on average. These mean scores, however, differed by gender with women generally scoring more positively on all versions and men scoring more negatively.

The significant software version by class interaction on the biology questions showed different trends between the two classes, some of which may be accounted for by the small sample size. For example, no one in my class was randomly assigned to the Web-page based version. For those in my class who used the plain multimedia version, their biology scores dropped an average of -.7778 and those using the counterstereotypic version increased

+1.5 on average (a 30% increase). For the other class, the Web-page based users saw no change in scores, those using plain multimedia saw an increase in post-software scores of +.3 and those using the counterstereotypic version saw a decrease in biology scores of -1.0 (a 20% drop). The graphs in Figure 7 illustrate the class by software version differences. ANOVA post hoc LSD tests showed that the only statistically significant difference was between the Web-page based and the counterstereotypic versions ($p=.042$). Table 3 shows these results.

Both the significance and the pattern were unexpected results since there were only five questions and since it was expected that software designed for review purposes would be used by students who had already mastered most of the material. For example, several students commented at the end of the class period that the software helped point out the material they did not yet know. I had not expected the design to be sensitive enough to detect changes in biology knowledge.

The differential biology content scores make sense in light of the significant class by software version interaction and the overall increase in stereotypic attitude scores. Although the differences between the two classes on stereotype attitudes were not statistically significant ($F=2.363$, $p=.141$) the patterns were very different. The average for all software versions in my class showed no improvement in stereotypic attitudes. In the other class section, however, group means for those using the Web-page based and the plain multimedia versions showed essentially no change in pre- to post-software scores (+.075 and +.065, respectively) but the group using the counterstereotypic version showed a +.3567 improvement. In short, the use of counterstereotypic clip art in my class correlated with an increase in biology knowledge and the use in the other class correlated with a more positive stereotypic attitudinal change. What does that indicate about using counterstereotypic clip art in the classroom?

These classes were selected because they were the only sections offered of this course. Although the research design did not anticipate differences between classes, these results make sense in light of the different ways culture was included in the two classes. The other teacher said she did not discuss culture during classtime because she did not know how to do that. She encouraged students to get to know their classmates, but did not conduct any class activities designed for that purpose. For example, she did not have students introduce themselves to each other on the first day of class. She said she did not think it was feasible considering the number of students in the class and the room arrangement. Instead her first day strategy was to reassure students that she was sympathetic to them and knew what they were going through since she was a student herself. She also told them about things she had done with students during previous semesters which showed how she had gone out of her way to help students succeed.

In contrast, I encouraged student interactions around culture in my class throughout the semester. For example, on the first day of class, I asked students to interview each other, in pairs, and to then introduce their partner to the class. Before we broke into pairs, I had the class brainstorm a list of questions they could ask of each other as "professional students". I added the last question to the list, "What is your cultural background?" After all the students had introduced their partner, I answered the same questions for them, telling them that my great-great-great-great-great grandmother Butler was a member of the Cherokee nation.

I also included a number of overt discussions throughout the semester which focused on student cultural backgrounds and which tried to value differences. On one occasion, I asked the two students from Africa to tell the class about each of their countries. The student from Thailand told the class about her country on another day and I then related a five-minute version of how the Hmong came from China via Laos and Thailand to the U.S., and that there were 4,000 Hmong currently living in Colorado.

Other conversations were more directly connected to biology. For example, we talked in class about sickle cell anemia which disproportionately affects Africans and African-Americans, about diabetes and its influence on Native Americans, and about the impact of Tay-Sachs on Ashkenazi Jews. One of the African students told the class about malaria in his country. Interviews and observation data from the other class section indicates that they discussed sickle-cell anemia as disproportionately affecting African-Americans and Tay-Sachs as prevalent among certain Jewish groups but failed to relate diabetes to Native Americans.

The differences in class context make it likely that if a student had not previously been exposed to discussions which raised the issue of cultural differences in either an affirmative or value-neutral manner, seeing counterstereotypic images for the first time could be expected to make an immediate impression which could reasonably appear as more positive scores on the post-software stereotype attitude scale, which is what was seen for those in the other class section. The students in that class who used the counterstereotypic version showed the greatest increase in more favorable stereotypic attitudes (group mean rose from 3.94 to 4.3). For students in my class, who had previously discussed cultural differences in a school setting, seeing cosmetic counterstereotypic images caused no dent in their stereotypes, but did contribute to increased success in biology scores.

It is also interesting that ethnicity did not have either a significant main effect or interaction effect, indicating that it operated as an independent factor. In other words, the influence of the counterstereotypic images in the software was similar for all ethnic groups.

Discussion

The class by software version interaction and its possible roots in the context of the course are both consistent with theoretical discussions in educational research of situated cognition (e.g., Brown, Collins, & Duguid, 1989) and situated learning (e.g., Lave & Wenger, 1991). These approaches direct attention to the apparent success of learning that occurs in group activities which extend beyond individual cognitive moments and reinforces the necessity of viewing learning within the social context in which it occurs.

These results are also consistent with research in social psychology around "outcome dependency" which exists when one person depends upon another to reach a goal or desired outcome. These psychologists have studied stereotypes in the social context of two people working toward a common goal and have shown that category-based stereotypes can be undermined by individuating processes of impression formation which occur when two people work toward a common goal. In other words, people working together will use specific information, rather than general information derived from racial categorization, to form an impression of the person with whom she or he is working.[12]

The specific information included in the software used here was cosmetic, with images which were neither integrated with the genetics content nor part of the overt affective learning goals of either class section. Yet, within a context of class discussion of cultural differences, such minor changes appeared to immediately influence the attitudes of students. The idea that class section differences may stem from differences in classroom interactions among students is consistent with trait attribution theory. The less that a student knows about another student who is an out-group member, the more likely they are to automatically make assumptions and rely on stereotypic information. Introducing students to each other, encouraging them to work together, and using counterstereotypic clip art appear to moderate this tendency.

These results have several implications for instructional and curriculum designers. First, science curricula could begin to include images of people of color which portray them in high-status occupations and with upper socio-economic backgrounds as a way of providing students with information which counters existing societal implicit stereotypes. Second, inclusion of cosmetic images is not alone sufficient to create changes in student stereotypes. Other educational reforms, such as class discussions on culture and how it relates to science need to be coupled with the use of such graphics.

Third, while overall results did not include a statistically significant effect of the counterstereotypic software version on biological knowledge, the significant class interaction and the overall changes in group means suggest a tentative model for changing student perceptions of who becomes a scientist. The initial exposure of students to counterstereotypic information impacts their implicit stereotypes. This step was seen with the other class section where exposure to the graphics correlated with more positive student stereotypes. In the second step, additional counterstereotypic information absorbed by a student who had already experienced some counterstereotypic information, such as during class discussions, helps students to be more successful in mastering science content. This step was seen with my class section where a second exposure to counterstereotypic information correlated with an increase in biology scores. This model is not linear, however, as the effect of encoding incidental exposure to stereotypic information present in society probably needs to be continually moderated through exposure to counterstereotypic information. This further supports the necessity of incorporating counterstereotypic information across all disciplines so that changes in stereotypes and success in content matter are given a chance to increase the attractiveness of studying science for minorities, a beginning toward increasing minority representation in the practice of science.

Notes

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1. While 3.5% of scientists were African-American that group comprised 12% of the population. Latino/Hispanics lost ground; they were 2.8% of the science and engineering workforce while growing to 10% of the total population (Committee on Equal Opportunity in Science and Engineering, CEOSE, 1996). That study also found that Blacks and Hispanics each accounted for only 2 percent of those working in science with Ph.D.'s while Native Americans accounted for less than one half of 1 percent.

2. Psychologists who investigate ethnic stereotyping believe that experiments which use gender as the basis for stereotyping are more reliable since they omit the possibility that subjects are reacting emotionally to race issues.

3. There is another significant aspect to Blair's research. The short time period she used (350 ms) is considered by psychologists to be a condition of "high cognitive constraint", meaning that the person has very few mental resources available for the task at hand. Kim & Baron (1988) suggest that conditions which tax cognitive capacity heighten stereotypic processing. Overload, fatigue, low task confidence, intoxication, drugs, threat, heat, incentives, sensory distraction, lack of structure, temporal constraints, and embarrassment have been shown to exacerbate stereotypic bias.

4. There is a third main theory about how stereotypes influence evaluative judgment, called expectancy-violation theory. This perspective suggests that when one's characteristics violate stereotype-based expectations, the evaluations are extreme in the direction of the violation (away from the stereotype). For example, if a Black has a quality that is more positive than expected, she or he will be rated more favorably that others with similar characteristics. Although the work which led to this theory is consistent with the ideas proposed here, expectancy-violation was rejected as too general and offering too many possibilities to be useful in designing software.

5. Coleman, Jussim and Kelley (1995) established similar responses for blacks.

6. The primary Hispanic-American shift was toward "happy" and "nice" for Hispanic males. On the pre-test, 17% marked "happy" and 20% marked "nice" while 83% marked "happy" and 73% choose "nice" on the post-test.

7. Some of the clip art had to be edited (i.e., a stethoscope was drawn around the neck of a woman since the Afrocentric collection did not include the image of a woman doctor. These are not new ideas. Guidelines from a major publisher in the 1970s ("Guidelines for Creating Positive Sexual and Racial Images in Educational Materials", suggested ways to "avoid racial and minority stereotypes in art" and includes ways to portray African Americans: avoid "skinny geniuses wearing glasses", show some African shirts, show luxury apartments for urban blacks, feature blacks as the focus of a picture and represent blacks in all professions, including medicine, law, and business. See also Henriksen and Patton, 1976.

8. Paivio (1971, 1978) argued that the use of two independent, interacting cognitive systems, a verbal one for processing text and an imaging system for processing pictures, explains the increased retention of information in pictures. Building on Paivio's "dual coding theory", Kulhavy, Stock & Kealy (1993) developed the idea of verbal and imagery systems which were interrelated by associative links.

9. The original research on this measurement instrument used only African-American stereotypes and the validation study included only data from white participants on the assumption that attitudes toward a member of one's own group are significantly different from attitudes about members of an "other" group. Here, after reviewing the questions, I created a second questionnaire for African-American students where they answered questions about "Hispanics" on the assumption that the stereotypes applied generally to "others" more than only to African-Americans. By including that data I was using an instrument which had not been validated for such use and more research on measurement instruments is needed.

10. So that students would not think that participation was in any way connected to their grades, a subtle form of coercion that is not acceptable for the study of human subjects, each student was given a set of labels with a 4-digit identification code which they placed on each instrument and used as identification at the beginning of the software program. For the experimental design, this also meant that no data could be collected before or after the day of software use since it would mean that I, as their teacher, knew which data was theirs.

11. The log was used to measure total minutes working with the software, minutes spent on genetics questions, number of pages viewed, number of answers entered, number of correct answers, whether the student "played" the program linearly by choosing sections in alphabetical order, and the number of minutes spent on both pre- and post-software biology questions.

12. One example of this kind of experiment can be seen in the 1987 work of Steven Neuberg and Susan Fiske. They conducted an experiment where subjects were told that they were going to work with a schizophrenic ex-mental hospital patient to design creative games. The schizophrenic label had been previously shown to be affectively negative so it was serving as the negative stereotypic piece of categorical information. Some of the participants were told that the team that designed the most games would win a cash prize (creating and manipulating the outcome dependency). Participants were then given one of two "profiles" of the patient which contained personal information (hobbies, interests, career goals, etc.). Those in the neutral group received a profile which was not consistent with schizophrenic traits while those in the dependency outcome group read a profile that was positive and discrepant to the negative schizophrenic label. This meant that each participant in the study would have to choose how to process the information contained in the profile which was inconsistent with the label of schizophrenic they had previously been given about the patient. Those in the dependency outcome group used individuating impression formation instead of the typical category-based evaluation, resulting in higher evaluations of the patient, while those in the neutral group assessed the patient using category-based processes, as indicated by their relatively low evaluations. This showed that if one is working with another toward a common goal, individuating information that is inconsistent with a stereotype category can undermine the stereotype.

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